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Analysis of the validity and reliability of a questionnaire to measure students' perception of inclusion of sustainability in engineering degrees

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Structured Abstract

Design/ Methodology / Approach
This paper shows the validation process of a questionnaire designed ad hoc to measure the students' perception on Sustainable Development inclusion level in three current engineering degrees, at the Engineering School of Bilbao (EIB) of the University of the Basque Country (UPV/EHU).The questionnaire validation process was conducted in three stages: experts on the subject provided their advice to ensure the study objectives, a small number of students contributed to clarify the statement of the questions, and thus, to increase the reliability of the questionnaire and, finally, a larger number of students completed the survey in order to analyse the internal consistency of the two scales in the questionnaire with the Cronbach's alpha test.
Purpose
There are multiple questionnaires in the literature that try to gather university students' perception about sustainable development, but they are mainly focused on determining the students' knowledge and attitude about Sustainability. Since the existing questionnaires did not fit the type of analysis that is intended to carry out, a new questionnaire was developed, adapted to the aims and context (engineering students) of the pretended study. The questionnaire contains two scales; one to determine the level of insertion of sustainability and the other to measure the importance that students give in their training process to the three dimensions of sustainability: economic, environmental, and social. This new instrument requires a validation process to ensure its content-validity, reliability, and clarity. This validation process is described in this paper.
Findings
As a result of the entire validation process, an appropriate scale has been obtained to measure the importance that students give to the three dimensions of sustainability, economic, environmental, and social, and to the sustainability overall. Furthermore an appropriate scale to measure the insertion level of sustainability in engineering studies has been developed. However, the insertion scale needs a revision in the items of social and economic dimension in order to be valid to conduct disaggregated studies by dimensions.

Originality
The surveys published in the literature try to determine the knowledge and attitude that students have regarding sustainable development (SD). However, this new questionnaire, whose validation process is described in this paper, aims to know how engineering students of the Engineering School of Bilbao perceive the level of insertion of SD in their academic programs, from a frequency perspective, and the importance they give to it, both personally and professionally, given to the analysis a holistic perspective. Thus, the questionnaire can be used by higher education institutions to design strategies for inserting SD in engineering studies.

Keywords Questionnaire validation, engineering degrees, students' perception on SD, inclusion level of SD.

Introduction

By the year 2005 Spanish Universities' Rectors Conference (CRUE), in the Guidelines for the Inclusion of Sustainability in the Curriculum, recommended the insertion of sustainability competences in universities:

> *"Universities must prepare professionals who are not only capable of using their knowledge in a scientific context, but also to meet social and environmental needs. The entire educational process must be approached holistically to implement sustainability skills across the board so that students can learn to make decisions and take actions based on sustainable criteria"* (CRUE, 2005).

Following this advice, when adapting engineering curricula to the European Higher Education Area (EHEA), some competences related mainly to the environment were included in engineering curriculums at the University of the Basque Country (UPV/EHUa, 2020).

However, in recent years there has been an evolution in the field of the Education for Sustainability (EfS). From a vision focused on the environmental dimension and content learning, towards a holistic and transformative model briefly described at Murga-Menoyo (2015, p. 64). This model defines not only the learning contents or learning outcomes, but also two other aspects as: the active approach and learning environment that should be employed; and the social transformation aspect (UNESCO, 2014, p. 12). This evolution means that, also, progress must be made towards this approach, with the transformative inclusion of EfS in engineering studies. This vision is supported by different voices (Fitzpatrick, 2017 & Boyle, 2004) that advocate the importance of including EfS in engineering studies, by the capacity for social transformation of this technological sector. Besides, other voices claim that the next generations of engineers will contribute to solving the serious problems caused by environmental degradation and climate change (Hunt, 2007 & Beanland and Hadgraft, 2014). Therefore, in order to cope with these challenges, engineers must acquire the sustainable development competencies set by UNESCO (UNESCO, 2017). It can be said, that the sustainable development competences should be considered in university curricula, and that they must be inserted in engineering curriculums through the transformative model of the Education for Sustainability (EfS) (Holmberg *et al.*, 2008).

The University of the Basque Country is also working in the same direction, in order to include SDGs (Sustainable Development Goals), and therefore, sustainability, along undergraduate and postgraduate courses, answering this way to the approach proposed by UNESCO, that bets to include SDGs in curriculum aided by the transformative model of EfS (UPV/EHUb, 2020). Actually, UNESCO claims that this model "empowers learners to take informed decisions and responsible actions for environmental integrity, economic viability and a just society for present and future generations" (UNESCO, 2017, p. 7). Overall, the proposed model by the UPV/EHU to include sustainability in the curriculums, tries to meet with the SDGs of the institutional 2030 agenda (UPV/EHUc, 2020), aided by EfS and the active teaching model developed at the university, called *ikdi*[3] (Sáez de Cámara *et al.*, 2021).

Thus, the process of embedding sustainability in UPV/EHU engineering studies has taken its first steps. It seems a good moment to know the current situation of SD within engineering curriculums, before continuing with a deeper insertion. With this aim, a questionnaire was designed to be distributed to students, in order to know student's vision about SD: the insertion level in the curriculum, the importance they give to it and the knowledge they have about; all in its three dimensions (economic, social and environmental). This paper show the first part of the study, the design and validation process of the instrument.

Instruments, literature review

In the literature, there are several questionnaires to assess the attitude and knowledge that students of higher education (HE), in general, and engineering students, in particular, have on sustainability. Nevertheless, they do not fit exactly with the study intended to carry out, at the engineering school of Bilbao. For example, Sunthonkanopong and Murphy (2019), validated a scale to measure the concern, attitude and action that the 5th year, Thai, Bachelor of Science in Industrial Education Engineering students had on the three dimensions of sustainability (economic, environmental and social). Biasutti and Frate, (2017) designed and validated a scale to detect changes in the students' attitude regarding sustainable development, in agriculture, engineering, primary education and psychology degrees, after including the principles of SD in higher education curricula in Italy. In this case, the scale was composed of four dimensions of SD (economic, social, environmental and educational), with 5 items for each dimension.

Other scales found in the literature focus on measuring knowledge, skills or literacy that students have regarding sustainable development. For example, Sánchez *et al*. (2018) measured the acquisition level of sustainability skills of computer engineering and telecommunications' degree students in the Spanish university system. The questionnaire was designed based on the sustainability competencies inserted in those degrees, and asked about the economic, social and environmental dimensions of sustainability. This questionnaire was a Likert scale of 34 questions, and was subjected to a content validation process by a group of experts and by a final-year students group. Azapagic, Perdan and Shallcross (2005), designed a survey to find out the level of knowledge about sustainable development of engineering students from 21 universities in 10 different countries, and so did Wee, Ariffin and Sahberdin (2017) about HE students in Malaysia. However, they also ask about attitude and awareness, with an ad hoc designed survey based on a previous one developed by UNESCO to know Mediterranean youth opinion about sustainability. In Australia, Eagle *et al.* (2010) asked about awareness to HE students, they used their own questionnaire, too. In the USA there is an important number of questionnaires, both for higher education and for other educational levels. For example, Ohio University developed an instrument they called ASK (Assessing Sustainability Knowledge) to determine the sustainability knowledge held by undergraduate students from the cited university in all three dimensions (environmental, economic, and social). In that work, Zwickle *et al.* (2013) started from a questionnaire of 30 items that was reduced to 16 after a validation process. With the same goal of knowing the sustainability knowledge of their students, at the University of Maryland, Horvath, Stewart and Shea (2013) designed their own instrument. Likewise, Jung, Park and Ahn (2019) made a questionnaire to determine the perception on social responsibility of Construction Engineering students in two universities in the south of United States, specifically regarding their knowledge and interest. Similar initiatives exist in other countries such as Nigeria: Akeel, Bell and Mitchell (2019) used ASK and SULITEST (HESI, 2020) questionnaires as a starting point to develop an instrument adapted to the context of that country. The questionnaire intended to determine the sustainability knowledge of the Nigerian engineering community (students, teachers and professionals). The explored dimensions were the economic, environmental, and social, among others. It is particularly interesting the Tan *et al*. (2017) instrument: construction engineering students were surveyed in UK to establish the extent in which sustainable development was embedded in the construction related curriculum, they were asked about the three dimensions.

In this brief description of questionnaires published to detect the perception of HE students about sustainability, in general, it is observed that the instruments are designed ad hoc for a specific context and research objectives. Some of the contributions also show validation processes or reliability studies of the instrument. The observed current trend is to ask students about the three dimensions of sustainability, and most of the surveys focus on determining students' knowledge, although there are surveys that try to gather the attitude or interest of students. The review also reveals that there is a lack of instruments to analyse the sustainability insertion level in HE and engineering degrees.

Validation and Reliability of an instrument

The **validity** of an instrument refers to the degree up to it measures what it is intended to (Lacave *et al*., 2015 & Hair *et al.,* 1999). According to the indications of Guglietta (2019), an instrument validation process can be done at two levels: on the one hand, expert validation, to adjust its content validity fitting it to the variables under study, and, on the other hand, the application of the instrument to a small sample of the population under study, to verify its clarity. Being the consultation to experts, the most common method in education (Prieto and Delgado, 2010).

The **reliability** of an instrument, refers to the confidence that is conferred on the information gathered with it, and is related to the coherence or internal consistency and the precision of the measurements collected (Lacave *et al.,* 2015 & Hair *et al.,* 1999). That is, reliability measures the degree to which extent, the data obtained are exempt from error (Guglietta, 2019).

The most widely used test to determine the internal consistency of a scale is Cronbach's alpha (Lacave *et al.*, 2015; Guglietta, 2019 & Oviedo and Arias, 2005). The mentioned coefficient takes values between 0 and 1, being the internal consistency of a scale acceptable for values higher than 0,7 (and 0,6 in exploratory researches) (Hair *et al.*, 1999).

The aims of the project and the survey design

The study is framed in the transformative EfS model defined by UPV/EHU, called *ikdi*[3] (Sáez de Cámara, *et al.,* 2021 & UPV/EHUb, 2020). It is not only that the students acquire an encyclopaedic knowledge about the SD, but also, that raise awareness about the topic, to make their own reflection and internalization, and, therefore, become change agents in their personal and professional spheres (UNESCO, 2014, p. 12). For this reason, this work inquires not only the level of inclusion and knowledge, but also the importance that students give to SD in their training and personal development. Moreover, the study includes the three dimensions of SD: the economic, social and environmental dimensions (Purvis *et al.,* 2019).

Although there are some studies in the literature (Thürer *et al.,* 2018; Byrne*, et al.,* 2010 & Tan *et al.,* 2017) that analyse the insertion of SD in engineering curriculums, none determines SD inclusion directly based on the frequency in which students identify activities related to SD like in this research. Therefore, lacking an instrument to satisfy all needs of the intended research, a new survey was designed. The instrument consists of 10 questions, and some of them (5, 6, 7, 8 and 9) have various items. Questions 5 and 6 are the insertion and importance scales composed by 15 common items (items can be consulted in appendix1). In the scales, there are 5 items per each dimension (economic, social and environmental) following the recommendations of Comrey (1985).

As told before, the items of the scale were designed to agree with the *ikdi*[3] teaching model, describing learning situations based in *ikdi*[3] model and the competences of the degree that students had to recognise in their activity, taking into account, this way, the particular context of the university. The items construction was inspired in the context, the SDGs and in items of other instruments of the literature review (Azapagic, *et al.,* 2005 & Zwickle *et al*., 2013).

The instrument was created to answer the following research questions:

- Do students know what Sustainable Development (SD) and Sustainable Development Goals (SDGs) are?
- Do students perceive the inclusion of the environmental, social and economic dimensions of SD in their engineering studies? Are there differences in the level of inclusion among the three dimensions? And between different grades?
- Do the students participate in SD training activities promoted by the university?
- What importance do students give to sustainable development in their personal and professional sphere?

The research variables were defined to answer that questions. The variables, their description and operation definitions (questions) are summarized in Table I.

Table I *Variables of study, definitions*

VARIABLES		
Name	**Conceptual Definition**	**Operative Definition**
Course	Degree Course in which student is enrolled. If he/she is enrolled in more than one course, the one with more enrolled subjects.	Answer to question 1: ***What Engineering course are you doing?*** The higher the number, the more advanced is in the studies
Degree	Name of the degree the student is doing	Answer to question 2: ***What degree of Engineering do you study?*** According to a dropdown that includes the three industrial engineering to be analysed (environmental is included for the validation version too). "Others" are included for students of ERASMUS or other exchange programs, which answers will be discarded in the analysis.
Knowledge about sustainable	He/she knows the sustainable development definition with its dimensions	Answer to question 3: ***Which of the following definitions of sustainable development is most familiar for you?***
Knowledge about the SDGs	He /she knows SDGs	Answer to question 4: ***In 2015, within the United Nations, world leaders adopted a set of 17 objectives, within the framework of the 2030 agenda, which are known as the SDGs. The purpose of these goals is:***
Insertion level of SD in the degree	Students' perception about the level of inclusion of SD in the degrees, in its three dimensions: environmental, social and economic	Answer to question 5. **Insertion Level scale, 15 items** (see appendix 1). The question asks how frequently activities related to the three dimensions of SD have been treated in the subjects of the degree. The contents of the items are inspired by the goals of the SDGs and the activities that, according to the competences of the grades, are carried out by the students in the engineering degrees under research. The items describe activities so that students can easily identify them.
Importance of SD	Importance that students give to the SD in their professional, personal and academic activities	Answer to question 6: **Importance scale, 15 items** (see appendix 1). ***To what extent do you think it is important for your training as an engineer?*** The same items of question number 5 are shown.

		Answer to question 9: ***How important is sustainable development for… you personally, you as engineer, your university, your country, the society in general, the following generations?*** Answer to question 10: ***Do you think that training that incorporates Sustainable Development is going to be a positive value to enter the labour market?***
SD insertion in non-formal learning	Assess whether students participate in SD activities developed by the university.	Answer to question 7: ***Have you participated in any of the activities promoted by the school or university in the area of sustainable development?***
	Assess whether students participate in activities outside the university on SD	Answer to question 8: ***Have you participated in any activity that promotes sustainable development outside the university? Such as collaborating with NGOs, in environmental protection associations, in neighbourhood associations….***

Note: The version of the operational definitions in Table pI are refined, after having gone through the experts and the pilot (version 3 in Figure 1).

The developed questionnaire will contribute to reduce the insufficient number of instruments to measure the inclusion of sustainability in engineering degrees, although only one was found in the literature revision (Tan *et al.,* 2017). Its novelty mainly lays in its new approach of the scale. That is, in the frequency in which students identify activities related to SD and its double entrance that help to identify the points of importance. This way a very relevant information will be obtained for teachers and institution in order to advance in sustainability inclusion at engineering schools at UPV/EHU. Note that although the instrument answers to the described particular context for engineering students at the UPV/EHU, might be modified to be used in other engineering schools with a transformative inclusion of SD..

Since the project needs the students' collaboration, the research's methodology (including the validation process) has been reviewed and approved by the UPV/EHU ethics committee.

Followed Methodology to validate the instrument

To validate the instrument a three-phase procedure was followed: a content validation by experts; a pilot to a small number of students to improve the reliability of the instrument by peer review, ensuring the understanding of statements of the questions; and finally, a survey distribution to a little sample of students, employed to carry out the statistical tests to measure the internal consistency of the scales (questions 5 and 6).
The aim of the validation process is to determine:

a) Whether the questions and instructions of the questionnaire are clear, univocal, understandable and easily answered by students.
b) Whether the three dimensions of sustainability have been adequately included in the questionnaire (content validity).
c) Whether the two scales of the questionnaire have enough internal consistency for the three dimensions of sustainability and globally, to measure the students' perception about the level of inclusion of sustainability in the degrees and the importance they give to the three dimensions of sustainability in their training (reliability).
d) Whether there is a difference in the inclusion of the three dimensions of sustainability between the three analysed degrees and the environmental engineering degree (content validity).

Figure 1 shows the procedure followed to design and validate the questionnaire, where the three stages of the study are shown: expert validation, pilot with a small number of students and validation and reliability analysis including a survey pass.

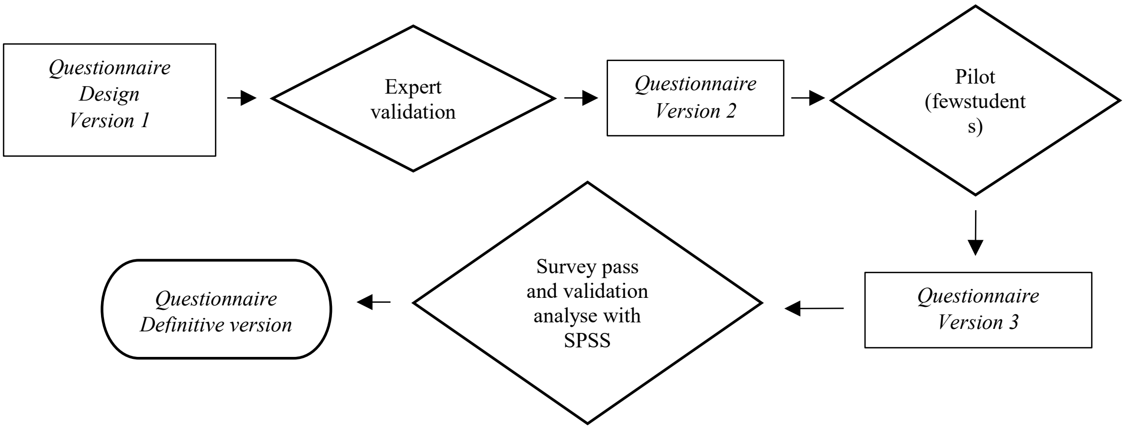

Figure 1: Procedure followed to design and validate the questionnaire.

In the third stage of the validation process, students from the last two courses of environmental engineering degree were included, as a contrast group, to explore if the scales are able to detect an expected difference in favour of the environmental engineering degree, with a higher insertion of SD competences in their curriculum, this would give a highest content validity to both scales.

Each stage of the study is described below.

Validation of the instrument by experts

The four experts that collaborated to validate the content of the questionnaire are academics with an important research career in the area and experienced in the inclusion of sustainability in HE. Three of them are teachers in engineering schools, and one of them is also in charge of managing sustainability in a HE institution, while the fourth is a pedagogue expert in the area. Questionnaire version one was sent, by email, with complementary information: the objective of the study, the research questions, population under study, and operative definitions of variables. The experts gave their comments and recommendations, both on the structure of the questionnaire and on the wording of some questions, as well as on their suitability to collect the foreseen information (content validity). Almost all the recommendations were taken into consideration and included in version 2.

Pilot

The 2nd version of the questionnaire was sent to a small group of students from the last two courses (3rd and 4th courses) of the grades under study (mechanic, electric and electronic engineers). Overall there were 12 students, 9 checked the version in Spanish and 3 the version in Basque. The pilot's students were recruited by members of the research team among students without a present or future entailment with the researchers involving a qualification process (requirement of the ethics committee).

The aim was to verify the clarity of the statements of the questions. In addition, the clarity of the instructions in the head of the Google Form was verified, and that the online form was user-friendly and its operation correct. Finally, this pilot allowed to test the necessary time to answer the form. Pilot feedback was used to increase clarity and understanding of the instrument, and thereby reduce ambiguity and the risk to gather wrong information. That is, its reliability was increased.

The original design of this pilot included a focus group with the students to analyse each and every one of the mentioned issues. However, due to the period of confinement caused by COVID19, a Google Form was sent to the students of the pilot, including the survey and extra questions about the issues that students had to analyse in the pilot, such as clarity, time to respond to the survey, use of the tool, etc.

Survey administration to students for the validity and reliability study.

In the third stage of the validation process, the version three of the questionnaire was sent to a sample of students enrolled in each of the four years of the degrees under study (2 groups for each course), ant to students of 3rd and 4th course of environmental engineering too.

The survey was sent through virtual classrooms. In order to satisfy the ethical criteria of the study, according to which researchers cannot send the surveys to their own students, twelve teachers not belonging to the research group, agreed to participate voluntarily, and sent the surveys to their students. Student recruitment was done by including a request to fill out the survey in the *virtual classroom news forum*. The study's objectives were explained in a letter (validated by the ethic committee of the university), and in the letter there was a link to the Google questionnaire.

Results

1st stage: Expert validation stage results

The most contribution from expert were incorporate to the instrument.

Regarding the content of the questions, the experts considered it was valid for both scales (questions 5 and 6), as well as for questions 7, 8, 9 and 10, and they did not suggest any review. The contents of knowledge questions (3 and 4) were more controversial, and were redacted again. Thus, this first revision improved the content validity of the instrument.

2nd Stage: Pilot

The reported information from students indicated that the statements of four questions (three items of the scales and the 9th question) were unclear or at least ambiguous, so they were improved. They also detected some typographical errors, and after students' suggestion, the writing of the header instructions was simplified. The pilot's information also served to verified that the Google Form operated correctly from any device (computer or mobiles), and that the mean time to complete the survey was less than 20 min. After including the changes in the instrument, it gained clarity, lost ambiguity and consequently gained reliability. The third version of the Google Form, was ready to be send to a sample of students.

3rd Stage: Administration of the survey to a sample of students and statistical analysis.

Once the data from the Google forms were collected, the database was organized, and the results were analysed with the IBM SPSS (V24) software.

Sample and response rate

Nulty (2008), situated the response rate between 20 and 47 % for online surveys. The number of students who were able to receive the questionnaire was approximately 300, so the response rate (54) was low (16 %), according to Nulty. The response rate of environmental engineers was 39 % a usual value. Nevertheless, to calculate the value of Cronbach's alpha of a scale (for an expected value of 0,7 and an error of 0,05) the minimum sample size required is 21 for a 5 items scales, and 18 for a 15 items instrument (Bujang *et al.,* 2018), satisfied condition in this study.

The participation, disaggregated by grades is shown in table II. The low response rate can be justified by the exceptional situation derived from COVID 19. Students do not attend the school and there is no certainty of the frequency in which they access their virtual classrooms, making it difficult to ensure that they received the information on time to answer. Furthermore, following the indications of Fan *et al*. (2010), a reminder should have been sent to students.

Table II *Number of responses obtained*

		COURSE				
		1	**2**	**3**	**4**	**TOTAL**
EGINEERING DEGREE	ENVIRONMENT			2	5	7
	ELECTRICITY	1		3	1	5
	ELECTRONICS	1	5	8	8	22
	MECANICAL	3	4	5	3	15
	ERASMUS (*)		1	2	2	5
						54

(*) Not included for the analysis

Importance and Insertion Level scales, analysis of their internal consistency

The internal consistency analyses were done with the data obtained from students of the four courses and the three grades (electric, electronics and mechanical degrees), in total 42.

Importance scale (6th question of the questionnaire): This scale tries to determine the importance that students give to the three dimensions of sustainability in their training. The Cronbach's alpha test was conducted for the three dimensions (environmental, social and economic), and results show (tables III, IV and V) alpha coefficients higher than 0,7 for the three dimensions, so the three dimensions have an acceptable internal consistency (Hair *et al.,* 1999). The social dimension has the highest internal consistency, followed by the environmental.

In the environmental dimension (table III), the alpha value is 0,786. The only item that if eliminated contributes to increase internal consistency of the dimension is item 6.1. However its contribution to the improvement of Cronbach's alpha coefficient is very small (only 0,003).

Table pIII *Importance scale, environmental dimension*

	Alpha if the question is removed	Alpha *Environmental dimension*	Difference
6.1	0,789		-0,003
6.2	0,750		0,036
6.3	0,688	0,786	0,098
6.4	0,753		0,033
6.5	0,739		0,047

In the social dimension (table IV), the value of Cronbach's alpha coefficient is 0,852. If question 6.9 is deleted alpha would increase to 0,854, an improvement (0,002) that is not considered relevant.

TableIV *Importance scale, social dimension*

	Alpha if the question is removed	Alpha *Social dimension*	Difference
6.6	0,798		0,054
6.7	0,807		0,045
6.8	0,817	0,852	0,035
6.9	0,854		-0,002
6.10	0,828		0,024

In the economic dimension (table V), the value of the coefficient is 0,791. All the questions contribute to increase the reliability of the dimension. Therefore, it is not necessary to remove any item.

Table V *Importance scale, economic dimension*

	Alpha if the question is removed	Alpha *Economic dimension*	Difference
6.11	0,736		0,055
6.12	0,722		0,069
6.13	0,790	0,791	0,001
6.14	0,759		0,032
6.15	0,745		0,046

Insertion Level scale (5th question in the questionnaire): This scale, which shares the items with the interest scale, aims to determine the perception that students have about the insertion level of the three dimensions of sustainability in the degrees.
The results of the Cronbach test that are shown in tables VI, VII and VIII indicate that only the environmental dimension has an acceptable internal consistency. The social dimension is the one that shows the lowest value, followed by the economic one.

For environmental dimension the Cronbach alpha value is 0,730 (acceptable). And deleting question 5.2 would increase the internal consistency of the dimension only by two thousandths, (table VI).

Table VI *Insertion Level scale, environmental dimension*

	Alpha if the question is removed	Alpha *Environmental dimension*	Difference
5.1	0,686		0,044
5.2	0,732		-0,002
5.3	0,682	0,730	0,048
5.4	0,631		0,099
5.5	0,678		0,052

The internal consistency of the social dimension (table VII) is not acceptable (alpha < 0,7), a situation that cannot be resolved only by eliminating item 5.10, which contributes to a significant decrease in internal consistency. These results shown the need to review all the questions of this social dimension.

Table VII *Insertion Level scale, social dimension*

	Alpha if the question is removed	Alpha *Social dimension*	Difference
5.6	0,548		0,053
5.7	0,523		0,078
5.8	0,543	0,601	0,058
5.9	0,456		0,045
5.10	0,655		-0,054

In the economic dimension (table VIII) the value of the constant is 0,646. Deleting question 5.11 would increase the internal consistency of the dimension, although it would not contribute to increasing the internal consistency to the minimum acceptable value. Consequently, it is necessary to review all the questions in this dimension.

Table VIII *Insertion Level scale, economic dimension*

	Alpha if the question is removed	Alpha *Economic dimension*	Difference
5.11	0,660		-0,014
5.12	0,618		0,028
5.13	0,605	0,646	0,041
5.14	0,562		0,084
5.15	0,541		0,105

Finally, although some authors do not recommend calculating the alpha for the total scale (Taber, 2018), the internal consistency of the insertion level scale (with its three dimensions) was analysed, the alpha value rises to an acceptable value: 0,845. Therefore, it may be appropriate using the full scale to analyse the overall level of insertion of sustainability, since the social and economic dimensions have less tradition in engineering studies (Azapagic *et al.*, 2005 & Fitzpatrick, 2017) and the activities related to them, may be still heterogeneous and, therefore, the dimensions less consistent.

In relation to the alpha value for the whole scale, it is also true that the alpha value tends to increase with more items, and not always accompanied by an increase in internal consistency (Cortina, 1993 & Taber, 2018). A factorial analysis could serve to confirm the goodness of the insertion scale, but a larger sample is needed for that test, at least 100 responses (Hair *et al.,* 1999), not available in this pilot.

Comparison between environmental engineering students and the rest of the students

A comparison was conducted, only with the students of the 3rd and 4th courses, to see if the scales discriminate between environmental engineering degree students, and the rest of the degrees. Performing an exploratory analysis of data, it was observed that the responses do not form normal distributions, therefore, to compare the responses of the two groups, median values seemed more representative than means values (Guglietta, 2019). Nevertheless, the mean values of the items were also compared with the non-parametric Mann Whitney *U* test.

Importance scale: Table IX summarizes the data obtained for question 6, aggregated by dimension. Medians values are higher or equal for the environmental engineering group, although with very little difference.

Regarding mean values, with exception of 6.15 item *"do projects or solve problems in collaboration with development cooperation initiatives",* in the rest, the means are higher for the environmental engineering group. But Mann-Whitney *U* test results indicate that there are only significant differences ($p < 0,05$) in two items of the environmental dimension, in favour of the environmental engineering group: in item 6.1 *"study the impact on biodiversity of an adopted solution"* ($U = 45,5$ $p = 0,015$); in item 6.11 "*value economic costs of a given solution in an integral way*" ($U = 49$ $p = 0,02$); and also in the environmental dimension as a whole ($U = 52,5$ $p = 0,048$). Overall, the scale detects that environmental engineering students give greater importance to the environmental dimension.

***Table IX** Descriptive statistics of the importance scale, environmental engineering vs other degrees*

Dimension	Degrees	Mean	Median	Standard Deviation	Variance
Environmental	others	4,50	4,70	0,607	0,369
	environmental	4,94	5,00	0,098	0,010
Social	others	4,27	4,40	0,77	0,590
	environmental	4,66	4,60	0,22	0,050
Economical	others	4,19	4,40	0,74	0,548
	environmental	4,49	4,40	0,55	0,305

Insertion Level scale: except for the economic dimension, the medians are equal or higher for the environmental engineering group. This result is consistent with the competences included in the syllabus, since environmental engineering degree program includes specific competencies for environmental sustainability and professional ethics.

Regarding the results obtained for the mean values, in the environmental engineering group it is lower in four items: in three items of the economic dimension (5.12; 5.13 and 5.15) and in one item of the environmental dimension (5.4). There is only significance in means differences for item 5.4 *"Identify measures to limit contamination or affection in a given place"* in favour of environmental engineering according to the Mann Whitney *U* test. ($U = 52$ $p = 0,021$).

***Table X** Descriptive statistics of the insertion level scale, environmental engineering vs other degrees*

Dimension	Degrees	Mean	Median	Standard Deviation	Variance
Environmental	others	2,25	2,10	0,657	0,431

	environmental	2,51	2,40	0,720	0,518
Social	environmental	1,74	1,80	0,495	0,246
	others	2,03	2,00	0,594	0,352
Economical	environmental	1,74	1,70	0,478	0,228
	others	1,74	1,60	0,513	0,263

Discussion

This validated questionnaire has similarities in some aspects with previously designed questionnaires, especially with regard to the awareness (interest) of students about sustainability in one or more dimensions (Biasutti and Frate, 2017; Eagle *et al*., 2010 & Jung, *et al.,* 2019). That also include questions about the attitude of students in their personal life towards sustainability. But, in this instrument the activities based scale within the degree is novel, as an indicator of the importance given by students to sustainability dimensions in their training.

Regarding the level of insertion in the degrees, there are previous instruments elaborated by Tan *et al.* (2017), and by Sanchez *et al.* (2018) to ask engineering students about their perception of knowledge and skills acquired on sustainability in order to establish insertion level of sustainability in the degrees. Nevertheless, in this case, students are asked about the activities carried out in the degree, this is more consistent with the transformative model of UNESCO (2017) and the *ikdi*[3] approach of the university (Sáez de Camara *et al.,* 2021), that is, based on the students' own activity. The novelty design of this instrument is more complex, because the type of activities to develop the sustainability competencies are still quite heterogeneous. To improve the homogeneity of the instrument, and this way the internal consistence of the scales, in addition to ask to the experts of the validation process, it would be interesting to ask to engineering lecturers about the activities for the insertion of sustainability.

The approach of this instrument is a necessary contribution for the engineering schools of the EHEA (European Higher Education Area), where the teaching model is focused on the active performance of the students (Bologna Process Secretariat, 2016), especially for institutions that try to include sustainability from a transformative point of view (UNESCO, 2017). Being this instrument more appropriate in EHEA context than surveys based on knowledge or attitudes. Although it is possible that it requires little adjustment for the different branches of engineering.

Conclusions

Several conclusions can be extracted from the work carried out during the validation of the questionnaire.

In the first stage, the collaboration of four experts have been proven useful, since their contributions complemented each other. Besides to improving the validity of the contents to study the intended variables, their comments have allowed to refine, complete, and improve the formulation of some of the questions.

The contributions of the pilot's students have allowed the survey to be reviewed from the peer perspective. Their comments have contributed to clarify the wording of some questions and avoid ambiguities, thereby improving the reliability of the instrument. Also, have helped to control the proper functioning of the online form, and to determine the estimated average time to complete the questionnaire.

Regarding the internal consistency of the scales, it has been validated that the scale of importance has adequate internal consistency for its three dimensions and as a whole. However, the scale of insertion level does not present an acceptable internal consistency in the economic and social dimensions, although it does in the environmental dimension and globally.

The set of the two scales could be addressed for the purposes of knowing globally the importance that students attach to sustainability for their professional development and their perception of the level of integration of sustainability in academic curricula. But it is recommended to confirm these result with a factorial analysis that is not possible to do in this pilot due to the available response number.

Regarding the comparison of 3rd and 4th year students between environmental engineering and the other engineering degrees, students of environmental engineering attach greater importance to the three dimensions of sustainability than the students of other engineering programmes. The scales, therefore, detect a difference between the students of the two groups, which support their validity.

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Appendix 1. *Insertion level and importance scales*

IMPORTANCE: Rate the importance for engineering studies from 1 (not important) to 5 (very important) the following activities, to…		Items	INSERTION LEVEL: In the activities that you have carried out in your training during your Engineering courses, either when working on theoretical aspects, when solving problems, when doing projects or internships or seminars, did you…				
1, 2, 3, 4, 5	**Item No.**		**Item No.**	**In no subject**	**In some Subjects**	**In most of the subjects**	**In all subjects**
	5.1	... analyse the impact of an adopted solution on biodiversity; for example, considering whether it affects fauna and flora, or protected areas.	6.1				
	5.2	... consider the complete lifecycle of elements, devices or facilities; taking into account, for example, their recycling or reuse	6.2				
	5.3	… consider as a design parameter to minimize the consumption of materials or resources; for example, in manufacturing processes, in constructions or in facilities	6.3				
	5.4	.. identify measures to minimize contamination or damage in an environment; for example, when an harmful industrial activity is carried out, or polluting elements are used (Hg, coolants, oils, fluorides ...)	6.4				
	5.5	… assess that the desired solutions are energy efficient; for example, choosing devices or systems with low energy consumption, or substituting some components for others with higher efficiency	6.5				
	5.6	… Identify the damages and / or benefits that the adopted solution will have for users or specific social groups; for example, improvements or deterioration in their living conditions.	6.6				
	5.7	…identify the occupational hazards involved in certain projects or tasks; for example, through safety and hygiene studies.	6.7				
	5.8	… assess the use of sensitive raw materials whose extraction harms specific populations, such as coltan in the Congo or gold in South America	6.8				
	5.9	…consider the accessibility aspect to design friendly or ergonomic tools or solutions; for example, for groups with special difficulties or for users in general.	6.9				
	5.10	…make decisions in accordance with the ethical principles of the profession; for example, considering safety, health and public welfare.	6.10				
	5.11	…evaluate economic costs of a given solution in a comprehensive way; for example, considering social and environmental costs.	6.11				

IMPORTANCE: Rate the importance for engineering studies from 1 (not important) to 5 (very important) the following activities, to…		Items	INSERTION LEVEL: In the activities that you have carried out in your training during your Engineering courses, either when working on theoretical aspects, when solving problems, when doing projects or internships or seminars, did you…				
1, 2, 3, 4, 5	**Item No.**		**Item No.**	**In no subject**	**In some Subjects**	**In most of the subjects**	**In all subjects**
	5.12	…critically analyse business actions, considering; for example, their impact on employment or social justice.	6.12				
	5.13	Consider the viability of long-term solutions, avoiding, for example, short-term and speculative returns.	6.13				
	5.14	…identify the social and environmental commitment of institutions and companies, reviewing, for example, their corporate plans or management systems.	6.14				
	5.15	…work in development cooperation scenarios, for example, in international cooperation projects or at the local level.	6.15				